NASA SpaceWire Architectures: Present & Future

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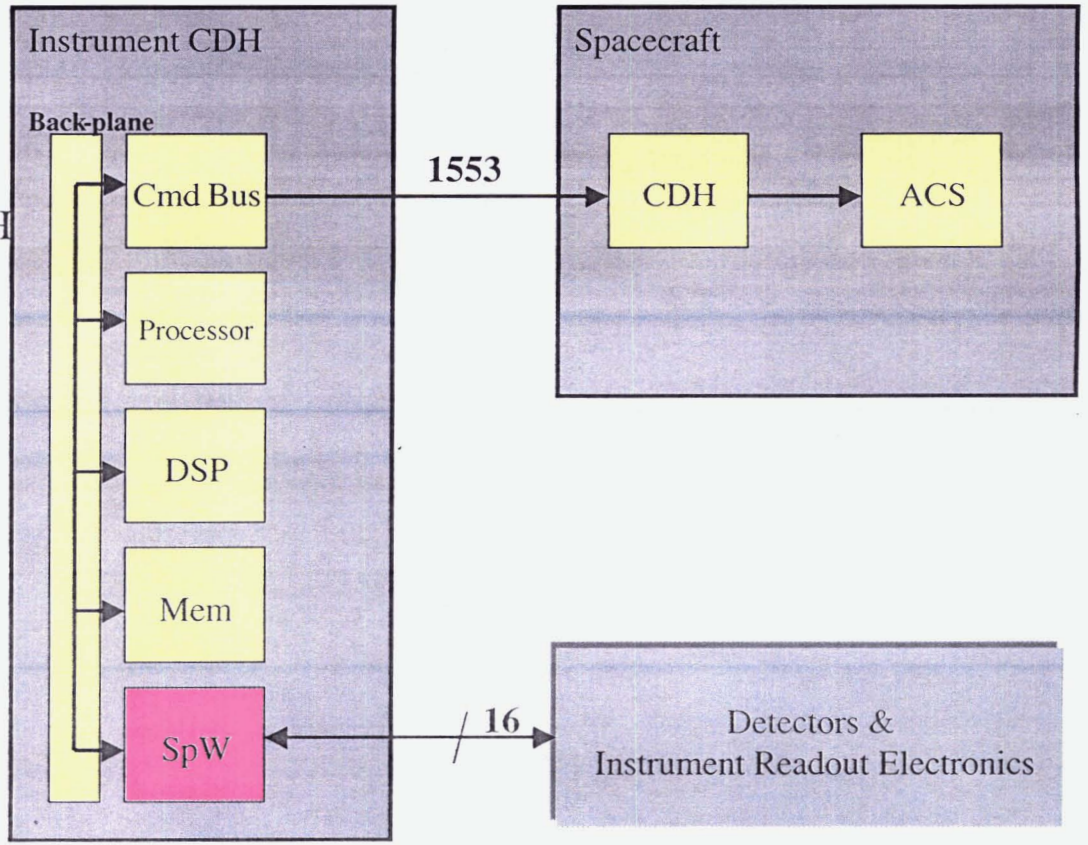
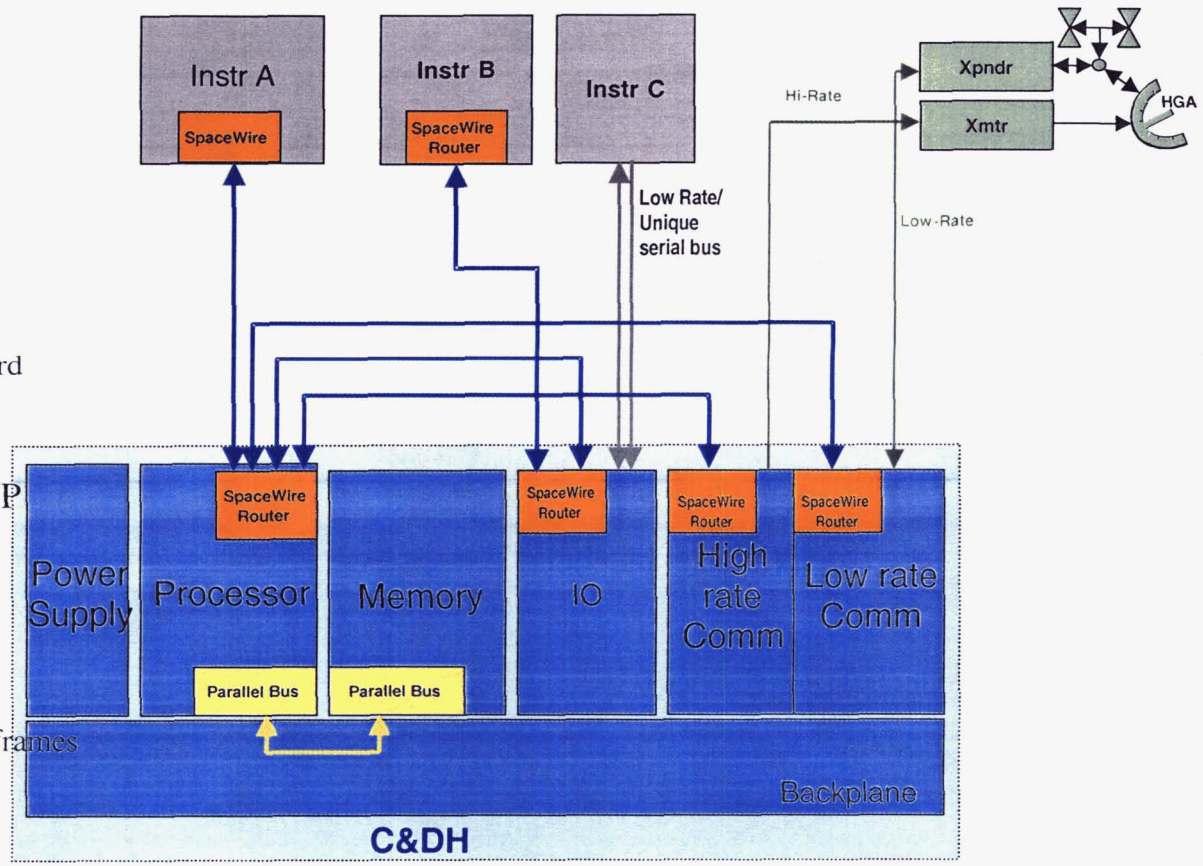
Current SpaceWire Architectures: Swift Data Flow

- SpaceWire point-to-point links
  - 16 links from segmented detector array & readout Electronics to Instrument CDH
    - Science Data & Commands
- PCI
  - Instrument CDH to Memory
    - Memory to DSP
- MIL-STD-1553
  - CMD bus to Spacecraft

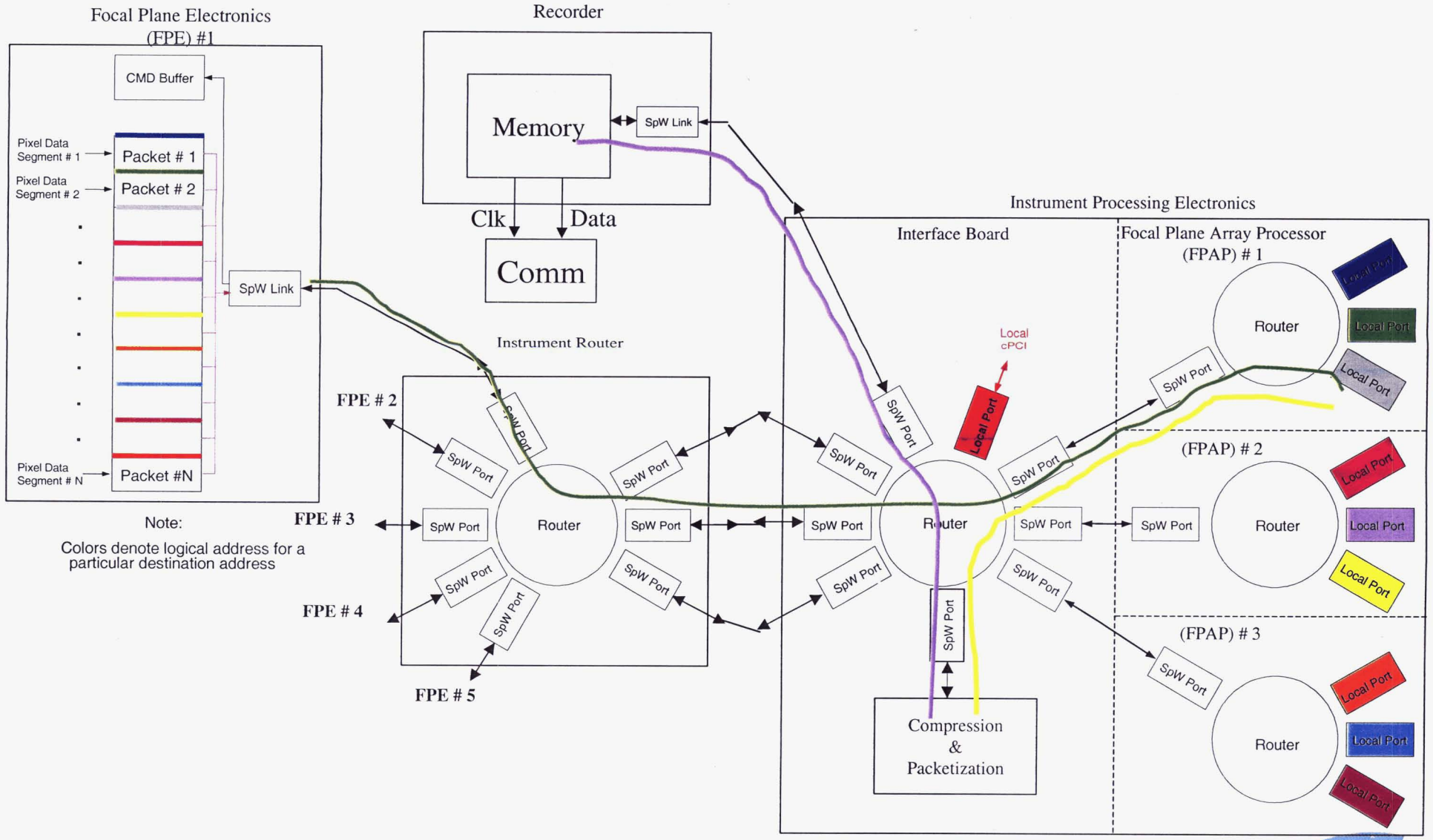


Current SpaceWire Architectures: LRO Data Flow

- Routed SpaceWire traffic
  - End-node routers on C&DH boards
    - –Used as Serial backplane
      - »Single Board Computer Board
      - »Instrument Interface Board
      - »S-Band Communication Board
      - »Ka-Band Communications Board
  - Interface to moderate rate instruments
  - Not memory mapped like RMAP or GAP
  - Side band signaling using Time-Codes
    - –1pps
    - –Barker code detect – uplink
    - –Upper level flow control on downlink frames
- MIL-STD-1553
  - Interface to spacecraft subsystem
  - Used for low-rate heritage instruments



Current SpaceWire Architectures: JWST Data Flow



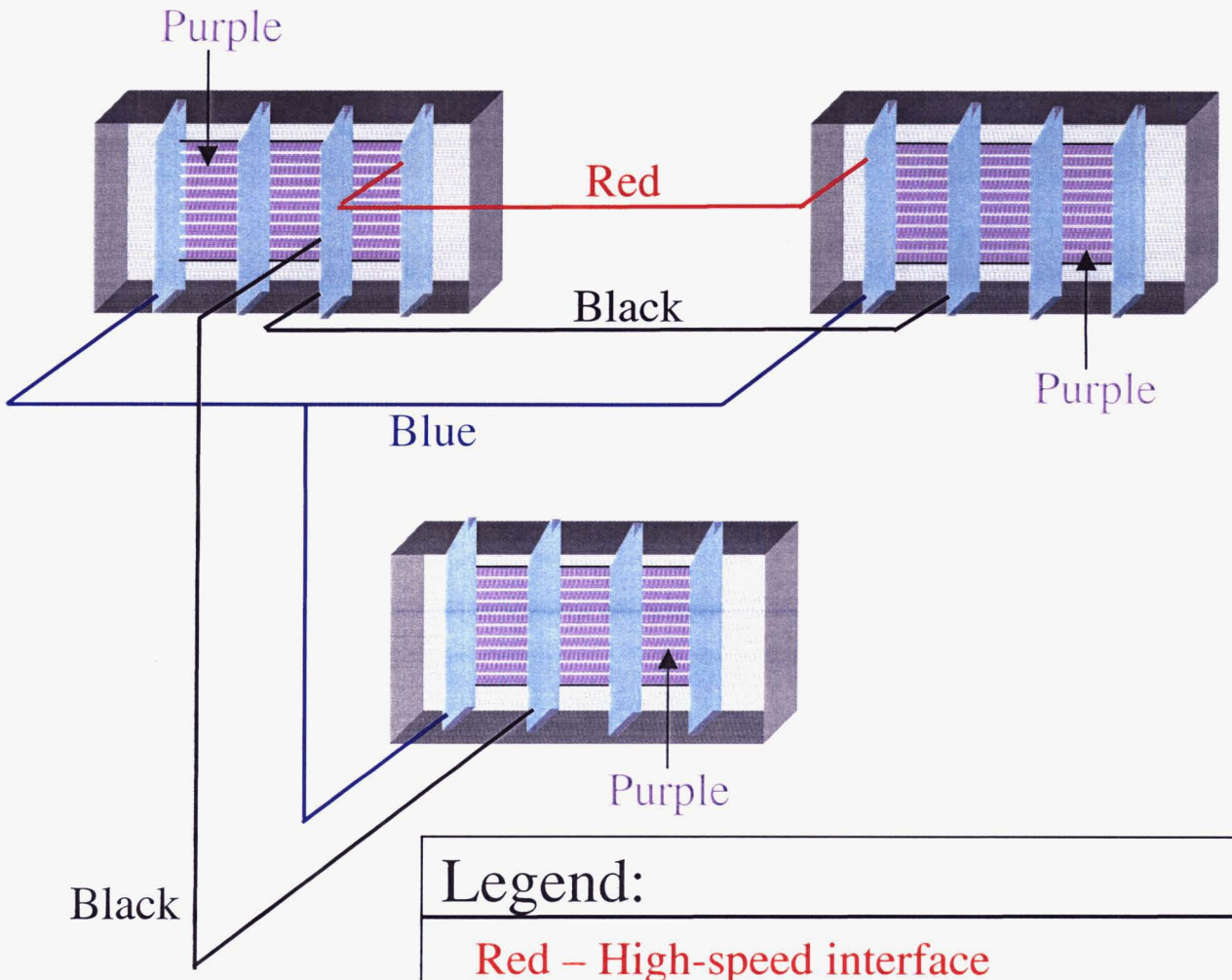
Current SpaceWire Architectures

- JWST
  - Routed SpaceWire traffic
    - From 4 instruments to local router to end node router (Instrument C&DH [IC&DH]) (cable)
    - ICDH end node router to hardware processors (same box over backplane)
    - Hardware processors to compression engine (same box over backplane)
    - Compression engine to recorder (cable)

- GOES-R – Point-to-point links
  - Instrument - C&DH with Reliable Data Delivery Protocol

Traditional Systems

- Different physical interfaces using different protocols that require unique hardware and software to bridge between them
- Serial interface at one point per enclosure @ NIC
- Extra board area and more power for multiple interfaces
- Only boards in same enclosure have memory mapped access via arbitration
- Enclosures represent limited access
- Reuse & reconfigurability limited



Legend:

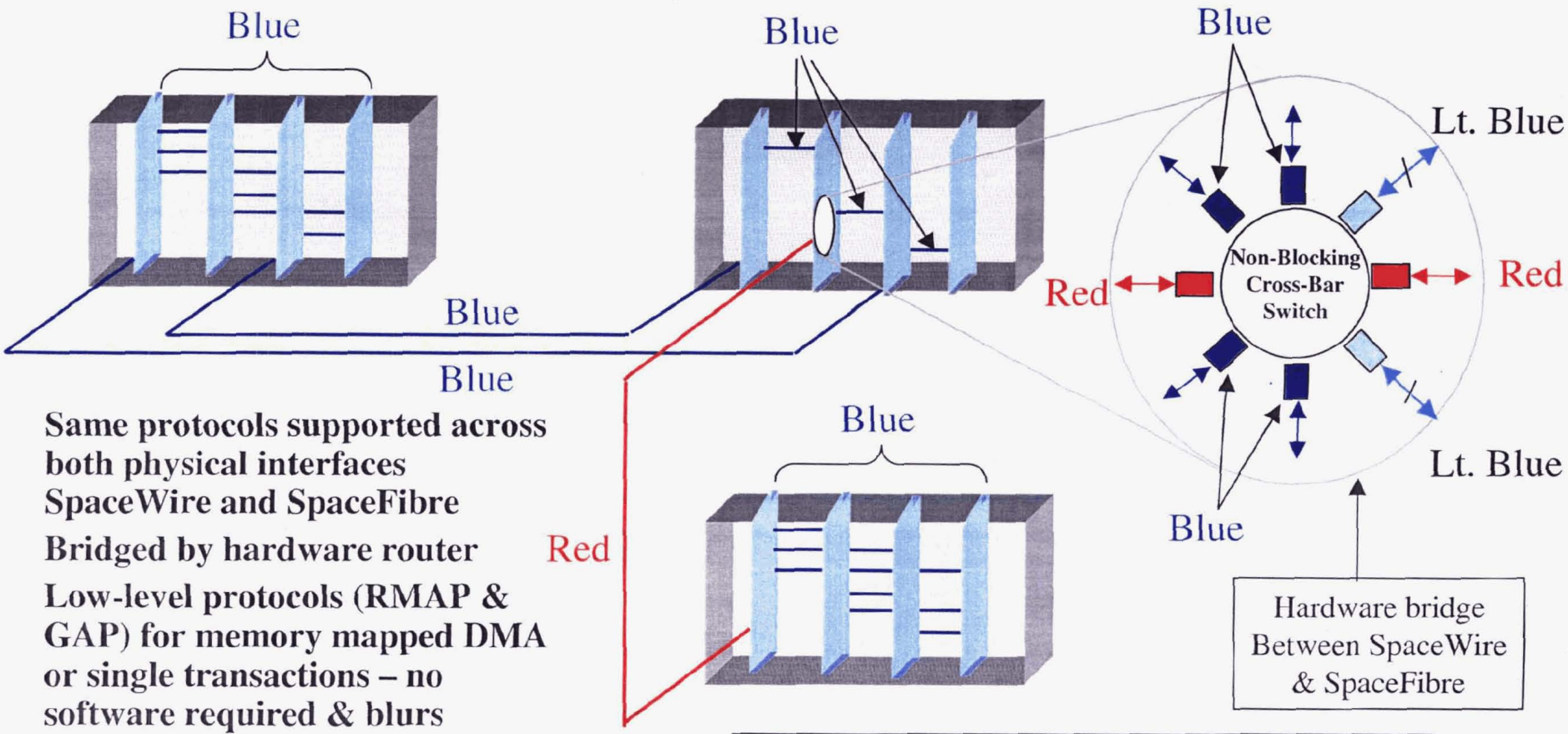
Red – High-speed interface

Black – Discrete sync pulse

Blue – TDMA low rate bus (MIL_STD-1553)

Purple – Parallel Backplane

Future Systems



- **Same protocols supported across both physical interfaces SpaceWire and SpaceFibre**
- **Bridged by hardware router**
- **Low-level protocols (RMAP & GAP) for memory mapped DMA or single transactions – no software required & blurs enclosure boundaries**
- **Plug and Play network mapping and Change-of-Status indication supported in hardware**
  - **Coming soon!**
- **Tunnel higher layer protocols**

Legend:

Red – SpaceFibre (optical or copper)

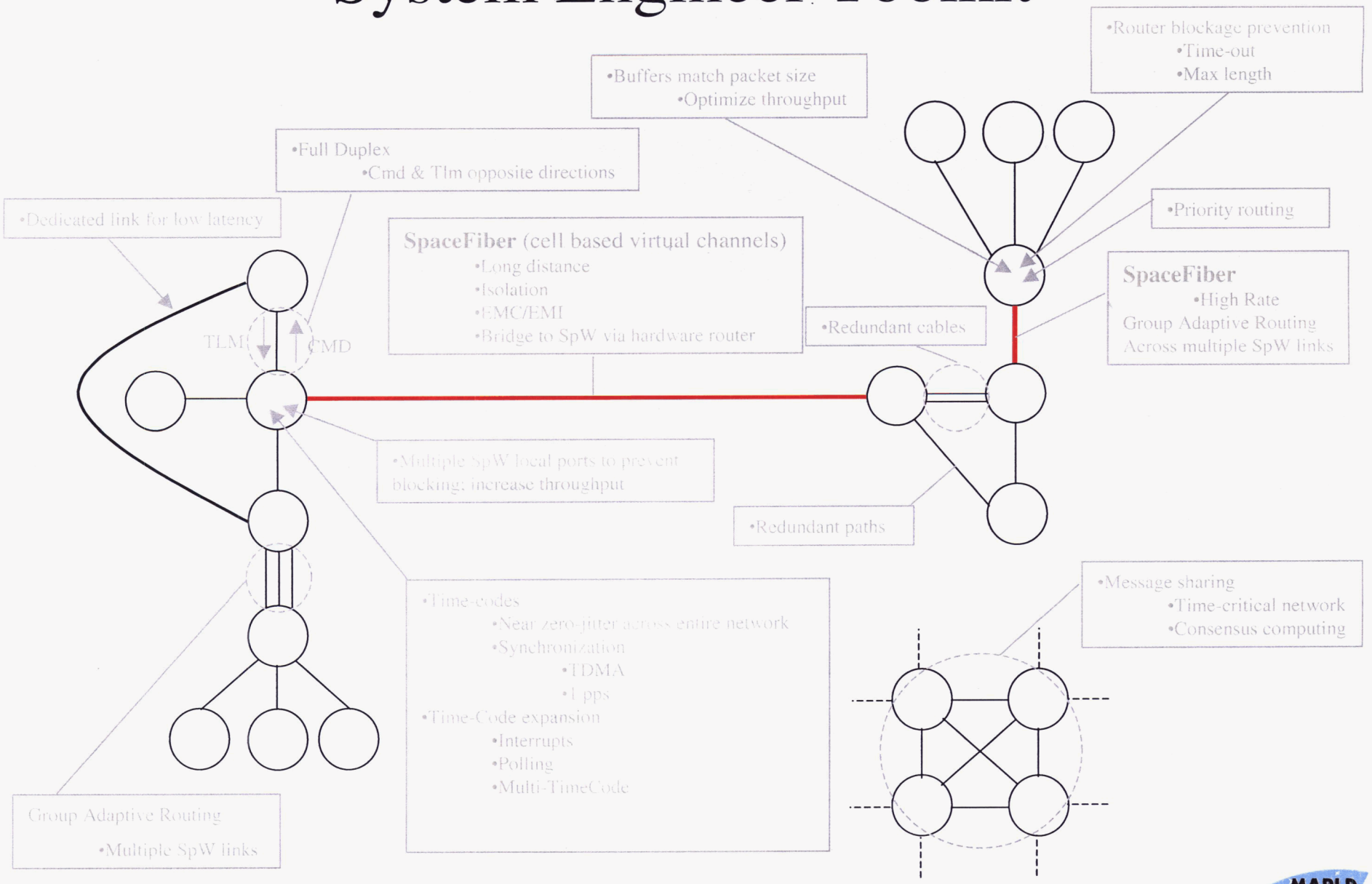
Blue – SpaceWire

Lt Blue – Local port interface (parallel)

Advantages

- One communications infrastructure
  - Simplifies system design
  - Consists of 2 different physical layers
    - SpaceWire
    - SpaceFibre
    - Bridged in hardware via routing switch
      - Seamless integration
- Supports low-level & high-level protocols
    - Virtual serial backplanes
      - RMAP & GAP
    - Upper layer protocol may be identified
      - Via Protocol ID (PID)
- Low latency bus
  - Wormhole routing
- Side-Band signaling
  - Reducing number of interfaces
  - Time-Code enhancements
    - Pending
- May be used as a time-triggered or event triggered bus
  - Time-triggered via Time-code defined slots
- Command bus features have been addressed
    - Cable redundancy (presented later)
      - Transparent mechanism has been implemented
        - » Proposed for standardization
    - Data retries
      - Protocol ID (PID) can accommodate Retry protocols
        - » MIL-STD-1553 over SpaceWire (no PID assigned)
        - » Reliable Data Delivery Protocol (RDDP) (no PID assigned)

System Engineer Toolkit



Conclusions

- Simple protocol that is being developed from bottom up to meet advanced spacecraft applications
- One bus standard can meet requirements
  - Real time control
  - Large data throughput
  - Safety
    - Guaranteed Low latency
    - High reliability
- Reuse & reconfiguration of systems easier with standard interface
  - Modular functions with standard interface
    - Serial interface
      - cable
      - backplane
- Provide system engineers more "tools" for more efficient designs